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SECTION OF GEOLOGY AND MINERALOGY

OCTOBER 7, 1946

DOCTOR NORMAN D. NEWELL, The American Museum of Natural History, and Columbia University, New York, N. Y.: *Geologic History of the Lake Titicaca Region, Peru.* (This lecture was illustrated by lantern slides.)

Lake Titicaca and the surrounding region in Peru and Bolivia form, from many points of view, one of the most fascinating areas on this globe. Among archaeologists, the locality is celebrated as the birthplace of some of the most remarkable ancient civilizations of the new world. To geographers, it occupies a place of exceptional interest as a great laboratory for the study of the struggle for existence under difficult conditions of environment. Geologically, also, this part of the Andes is of exceptional interest.

Lake Titicaca lies near the mid-point of the Andean Cordilleras, so that its geology has a strategic bearing on the geological problems of regions to the south and northwest. The stratigraphic sequence is enormous. I have measured a sequence, in post-Silurian rocks, of more than 12 miles of strata, around Lake Titicaca. Additional thousands of feet of Early Paleozoic strata are known to occur in adjoining areas.

This region lies near the apex of the great structural re-entrant of the Central Andes, responsible for the notch in the continental margin,

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the Gulf of Peru. This anomaly in the coastline has long intrigued students of South American geology. Examination of geologic evidence suggests that the margin of the continent has been mashed against a resistant massif now covered by the adjacent Pacific Ocean. Old injection gneisses crop out along the coast of the Peruvian Gulf at various places between Paracas, latitude 14° south, to Cabo Tablas, at 32°, near Valparaiso. The structural alignment in this basement complex is not parallel with the regional strike of the Andes. The grain of the later Andean folds is, however, parallel with the coastline. Existing data demonstrate a pre-Mesozoic, and probably a pre-Cambrian, age for these old rocks. Early Mesozoic marine strata overlie the basement complex at several places along the coast.

There are reasons for suspecting that the coastline of southern Peru lies very near a stable axis of tilting. The Krummel Deep parallels the coast and lies about 100 miles or less from the crest of the Western Cordillera. The present shore is about midway between the Oceanic Deep and the high peaks, and the shore has occupied about the same relative position since at least the Miocene. One is tempted to judge that the rise of the Andean Arch in this area has been very nicely compensated by the sinking of the Krummel Deep. If the continent were to be flooded by a eustatic rise of the sea level of 700 feet or more, the Andes would resemble some of the great island arcs of the Pacific region. The area is noted for active volcanism and deep and shallow earthquakes.

An area around Titicaca was systematically studied by me during approximately one year spent in the field. In many instances, the interpretation of the local geology so depended on knowledge of surrounding areas that many trips were made into adjoining areas, especially the coastal region and the area to the northwest of Lake Titicaca.

The Andes are very high, and very young, which has led to a popular misconception that they are also everywhere quite rugged. As a matter of fact, canyon cutting has by no means kept pace with uplift, so that there are vast areas of relatively level plateau upland in the Central Andes. This plateau is rimmed to the west by a chain of volcanic cones and bedded volcanics, forming one of the truly great volcanic areas of the world. The volcanic range, or Western Cordillera, includes many active or recently active volcanoes, some of which rise to elevations of around 20,000 feet above sea level. To the east, the Central Andes are bounded by mighty snow-capped ranges composed

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of early Paleozoic rocks. In some instances, these mountains owe their great relief to block faulting. In other cases, they are erosion residuals.

Erosion of the Pacific and Amazon slopes of the Andes is very unequal. The dry climate of the Pacific slope results in greatly retarded erosion, so that in some places the front of the Andes presents a gently arching surface with broad, flat divide areas. On the east slope, enormous canyons are being cut back into the mountains from the Amazon drainage. Some of these are profound chasms a mile and a half deep. On both sides of the Andes, canyons are encroaching on an upland surface of late maturity.

This upland plateau, or Puna peneplain, is one of the most remarkable in the world. It was carved mainly in the latest Tertiary, following the last main compression of the Andes (Miocene?), and has been modified more recently by block faulting and by regional epeirogenic uplift to a present high level of around 14,000 feet. Most of the volcanics of the Western Cordillera are essentially horizontal on this old peneplain.

In southern Peru and Bolivia, block faulting has caused the local collapse and settling of the Puna plateau to form a great basin, one of the world's great systems of internal drainage, the Altiplano, in the northern part of which lies Lake Titicaca. During the Pliocene and perhaps the early Pleistocene, the Altiplano was occupied by enormous lakes, of which Titicaca, Poopó, and the great salars of Bolivia are the relicts. The deposits of these lakes and their tributary streams form an enormous lacustrine-alluvial plain, most of which lies at elevations of 11,000 to 13,000 feet above sea level, a thousand feet or so below the surrounding plateau.

Lake Titicaca is a fresh-water lake about the size of Lake Ontario, with a maximum depth of around 1,000 feet. It is deepest near the northwest border, where there is geologic as well as topographic evidence of block faulting. The shore is generally precipitous, with numerous drowned estuaries cut by streams, evidently when the lake had a lower level than at present. The southwestern margin of the lake, on the other hand, is characterized by broad alluvial plains, and a rather large delta (Rio Ylave) is built far out into the lake.

Due to the high altitude and other factors, the area around the lake has but a thin cover of vegetation. Consequently, the erosional processes and resultant forms resemble those of semi-arid regions.

Actually, the annual precipitation is said to be not far from 40 inches. The growing season, however, is short, and the altitude is too great for the majority of crops and for arboreal vegetation. During much of the year, the climate is unpleasant.

Evidences abound for a formerly great and flourishing, indigenous human culture, where now the environment is inhospitable. It is interesting to speculate on the possible physical changes that may have been directly responsible for the cultural decline in the region, during the last thirteen centuries or so.

According to the legends of the Incas, the first Inca and his wife came down from the sun to an island in Lake Titicaca. They made their way northwestward to a new region outside of the lake basin, near Cuzco, where they founded the first Inca dynasty. Some centuries later, about 1200 A.D., during the rapid expansion of the Inca Empire, the warrior Inca, Mayta Capac, came as a conqueror to the southern end of Lake Titicaca. There he found impressive remains of an ancient civilization, which appears to have centered around the ruined city of Tiahuanaco. Living in the area was a primitive people who could give the Inca but little information about the ruins. The numerous vestiges of an advanced culture, particularly the impressive architecture, are said to have influenced the later Inca civilization in many ways.

This much is certain, that neither during nor since its domination by the Incas, did the area ever recover the former high cultural level enjoyed by the Tiahuanaco people. Evidences are abundant around the lake for a former very dense agrarian population. Impressive are the ubiquitous agricultural terraces on almost all hill slopes around the lake. These extend from lake level to elevations of around 13,800 feet.

The present population of the region is nearly pure Indian, direct descendants of the people who originally inhabited the area. Though degenerated through centuries of misrule and abuse, they are well adapted to the harsh environment in which they live. They still retain many of their ancient cultural traits, after four centuries of contact with Europeans.

Visitors in the region suffer, in varying degrees, from discomfort due to the high altitude. For many, the ascent from the coast to the Altiplano is very hazardous and, if not fatal, may at least be permanently damaging. For the majority of healthy young people, adjustment is rapid and complete. Normally three or four weeks of

limited activity are needed before heavy exertion can be tolerated. The majority of white men who work in the high Andes descend to the coast, to rest, at six-month intervals.

Special conditions in the prosecution of my work permitted the adoption of field methods which enabled me to travel continuously, moving my camp each day. My pack train was sent ahead with instructions to make camp at a given point. These arbitrary camp sites were plotted on excellent topographic sheets of the Carta Nacionál of Peru. Unfortunately, many local terms which appear on the published maps are not in general use. My assistant and I had to search for our camp far into the night on several occasions, under hazardous circumstances. However, by any other procedure, time would not have been adequate to complete the regional survey.

The stratigraphic section measured around the lake is, in the aggregate, enormous, measuring in the order of 65,000 feet. This includes Lower and Middle Devonian, Lower Permian, Upper Jurassic, Middle and Upper Cretaceous, and Tertiary rocks. Approximately one-half of the entire column studied belongs to the Tertiary, which consists of non-marine sediments and volcanics.

The most noteworthy general features of the geologic structure are several basins, separated by uplifts, or massifs, and numerous large faults, both normal faults and low-angle overthrusts. The majority of these principal structural features were formed during and before the last great compression of the Andes, probably no later than the Miocene.

The salient features of the geological history were determined by: (1) studies of the rocks themselves, with their enclosed fossils; and (2) the character and distribution of unconformities which shed light on the times of orogeny.

After the Middle Devonian seas were expelled from the region, by uplift, the area was probably subjected to erosion until encroachment by the Early Permian seas from the northward. During this great span of geologic time, there was negligible warping of the area in Bolivia and southern Peru.

It is uncertain whether or not the area was folded at the close of the Paleozoic. There was considerable volcanic activity during the Lower Permian in central Peru, but Permian and Triassic strata are essentially parallel in Argentina and at least locally in central Peru. In the Titicaca area, the youngest Paleozoic (Lower Permian) and the oldest Mesozoic (Upper Jurassic) do not occur in the same areas.

Nevertheless, the Jurassic rests with angular relations on tilted Devonian, and elsewhere the Devonian and Permian are parallel. An orogeny is indicated somewhere within the span of this interval, between the Devonian and Jurassic. It may have been one of the Hercynian stages. Angular relations between the Middle Cretaceous and Upper Jurassic rocks suggest a Nevadian orogeny. These Middle Cretaceous rocks truncate across all older rocks. Evidently, this was one of the most significant orogenic cycles in the history of the Central Andes.

The overlap of Upper Cretaceous rocks onto older rocks in the Eastern Cordillera indicates some activity, in that region, near the beginning of the Senonian.

No Laramide orogeny has thus far been recognized in the eastern Andes of Argentina, Bolivia, and Peru. However, the Flysch-like Early Tertiary deposits, of enormous thickness, in the Altiplano, truncate all older rocks. Their coarse texture implies deposition in a region of high relief, in which depositional basins were continuously sinking to receive sediments. Abundantly contained volcanic materials indicate active volcanism, probably in the Western Cordillera.

The development of the modern Andes, since the beginning of the Tertiary, may be divided into a series of stages. There is no general agreement regarding the sequence of events, nor their dating. Our information is no more complete than it was for the Rocky Mountains sixty years ago.

In the Early Tertiary, intermontane or Piedmont basins were filled with thousands of meters of coarse red arkosic beds, containing gypsiferous shales toward the top (Puno group). These beds were disturbed (Miocene?), and the folds were truncated by erosion.

Then came the third great period of volcanism in the Western Cordillera (Tacaza), following the earlier volcanism of the Early Jurassic (Chocolate) and Early Tertiary (Puno). The third stage of volcanism resulted in great piles of bedded volcanics, locally attaining more than 3000 meters in thickness.

The last orogenic cycle of the Central Andes followed. The region was broken by great folds and overthrusts, which were shoved from opposite directions on the two sides of Titicaca. There is no conclusive fossil evidence which can be used for the dating of this orogenic cycle. None the less, it could hardly have occurred earlier than Pliocene. Such paleontologic evidence as is available indicates a Late Tertiary date.

The great upland Puna peneplain of the Andes was formed after this orogeny. Since the erosion surface truncates the great structures with amazing evenness, it would seem to indicate a long epoch of erosion, resulting in late mature topography not far above sea level.

The great volcanic blanket of the Western Cordillera, measuring up to hundreds of meters in thickness, rests on this old peneplain. Likewise, the basin of the Altiplano is clearly a younger topographic and structural feature, formed by the down-warping and collapse of the old Puna surface. The first lake to occupy the basin was clearly pre-Glacial. It may or may not have lasted into the Pleistocene. It is not certain that the Andes had yet risen high enough to be glaciated during the earliest stage of the Pleistocene. The ancestor of Titicaca (Lake Ballivián) left high water marks in the form of wave marks and lacustrine deposits up to 100 meters or more above the present level of Titicaca.

The water level dropped to its present elevation by downcutting of the outlet, Rio Desaguadero. The configuration of the present floor of Lake Titicaca suggests quite recent activity along the northeast margin, producing a very deep and youthful basin, in which sediments have only just begun to level the bottom.

The latest subsidence in the level of Lake Titicaca, still in progress, seems to be correlated with increasing aridity of the region and recession of the glaciers in the surrounding ranges.

SECTION OF BIOLOGY

October 14, 1946

Doctor Louis M. Pruess, Research Department, Lederle Laboratories Division of American Cyanamid Company, Pearl River, New York: *Streptomycin.*

In preparing this paper, I have purposely omitted most of the details of the topic. Instead, I have confined myself to a general presentation or summary of the origin, nature, properties, clinical use, and limitations of streptomycin.

The story of penicillin is a familiar one. As will be recalled, its discovery by Fleming was, in a sense, accidental. The story of streptomycin, however, is entirely different. This antibiotic substance was discovered, not by chance, but as the result of a deliberate search for a product capable of exerting a bacteriostatic or bactericidal effect upon gram-negative bacteria, and not only active against these organisms in the test tube but also in the animal body, yet not very toxic. In other words, it was a planned search for a substance offering chemotherapeutic potentialities. Professor Selman Waksman and his collaborators of the New Jersey Agricultural Experiment Station, at Rutgers University, reported in January, 1944, that they had found such an agent. They called it streptomycin, the name being derived from the generic designation of the organism producing the substance, a sporulating and aerial-mycelium-forming species of the Actinomycetes, *Streptomyces griseus.* The characteristics of this organism relate it to both bacteria and molds. Two cultures of the streptomycin-producing strain of *Streptomyces griseus* were obtained, one from a heavily manured field soil and the other, a somewhat less active form, from the throat of a chicken.

Streptomycin can be produced in both natural and synthetic media, in submerged as well as surface culture. Waksman's group originally adopted a medium consisting of 1% glucose-0.5% peptone-0.5% meat extract-0.5% NaCl, pH 6.5–7.0. It was soon found that the nitrogen and carbon sources in the medium are more or less non-specific, and such cheaper materials as corn steep liquor, soy-bean meal, milk and yeast by-products, or known chemical compounds in the form of syn-

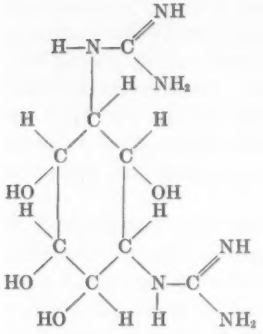
thetic or semi-synthetic media could replace the more expensive peptone and meat extract of Waksman's original medium. The yield of streptomycin, of course, depends upon the strain, medium, fermentation conditions, and recovery process used in its production. In submerged culture, maximum growth usually occurs in two days, accompanied in one to three days by maximum potency. In stationary culture, the maximum activity is usually reached at a somewhat later time, seven to ten days. Temperatures between 25–30° C. have been found to be optimum. Although the organism grows well at temperatures higher than 30°, streptomycin formation decreases, and at temperatures lower than 25° it is retarded. Strains of *Streptomyces griseus* that produce streptomycin may undergo variation. Inactive variants isolated from such cultures are characterized by the fact that they are sensitive to the antibiotic action of streptomycin, produce no aerial mycelium, form no streptomycin, undergo rapid lysis, give rise to an acid reaction, and yield a viscous broth.

Streptomycin is an organic base soluble in water and insoluble in organic solvents. Concentrates can be prepared as follows. The mass of growth of the organism is separated from the acidified culture medium, by filtration. The selection of a filter and filter aid is important, since streptomycin is adsorbed on some materials. The cell-free culture fluid is then made alkaline and treated with active carbon, which adsorbs the antibiotic. The carbon is filtered off, washed with water or alcohol to remove some of the impurities, and the streptomycin is then usually eluted with acid methanol. After removal of the carbon, the acid eluate is neutralized and then filtered to remove impurities that may have precipitated out. The resulting filtrate is evaporated *in vacuo* to a concentrate. A solid preparation may be obtained by precipitation of such a concentrate with ether or acetone, or by desiccation *in vacuo*. From such concentrates, *via* the picrate salt and subsequent chromatography, three crystalline salts of streptomycin have been prepared. One is the reineckate sulfate, a double salt, which crystallizes from water in thin plates and decomposes at 162–164° C. Another is the helianthate, which is recrystallized from aqueous methanol. The anhydrous helianthate darkens at 205° and melts with decomposition at 220–226°. The third is streptomycin trihydrochloride-calcium chloride. This colorless double salt crystallizes from alcohol as needles, and decomposes between 200–230°. All these salts can be converted to streptomycin hydrochloride or the sulfate, the commonly dispensed

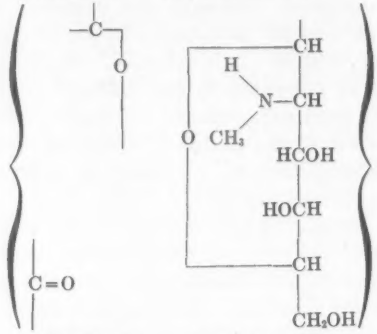
forms. From various analytical data, the present formula of streptomycin is given as $C_{21}H_{39}N_7O_{12}$. Without going into any of the details, I will merely state that the experimental results, thus far, indicate that streptomycin has the following general constitution:

$C_{21}H_{39}N_7O_{12} + H_2O = C_8H_{18}N_6O_4 + C_{13}H_{22}NO_9$
(Streptomycin) (Streptidine) (Streptobiosamine)

$C_{13}H_{22}NO_9 + H_2O = C_6H_{10}O_5 + C_7H_{15}NO_5$
(Streptobiosamine) (Streptonose or Streptose) (N-methyl-alpha-levo-glucosamine)



(Streptidine)



(Streptonose or Streptose) (N-methyl-alpha-levo-glucosamine)

(Streptobiosamine)

Streptomycin is completely inactivated on standing in acid solution, undergoing hydrolytic cleavage into two basic fractions which have been designated as streptidine and streptobiosamine. The streptidine, 2,4,5,6-tetrahydroxy-1,3-diguanido-cyclohexane, is attached through a glycosidic linkage to the nitrogen-containing, disaccharide-like streptobiosamine molecule. The latter half of the streptomycin molecule is composed of N-methyl-alpha-levo-glucosamine, the carbonyl group of which is glycosidically joined to a moiety called streptonose or streptose, and which contains a free or potential carbonyl group. This carbonyl group is changed to an alcohol group when streptomycin is catalytically hydrogenated to yield dihydrostreptomycin. The latter compound has practically the same antibacterial activity as streptomycin. Unlike streptomycin, the dihydro derivative was found to be stable in alkaline solution, and it was not inactivated by hydroxylamine, semicarbazide, or cysteine. Where the linkages are in the streptomycin molecule, and what is the constitution of the streptonose

or streptose moiety of the streptobiosamine half, remain to be determined for a complete picture of the structure of streptomycin.*

In contrast to penicillin, streptomycin is markedly stable. Dilute sterile solutions have maintained their initial activity after fifteen to seventeen days at 37° C. Heating solutions of streptomycin for ten minutes at 100° C. produces an inactivation of less than 50 per cent. The substance is not destroyed by microorganisms, as are such antibiotics as penicillin, gliotoxin, and pyocyanase. Waksman has reported that when streptomycin solutions, prepared on the one hand with water and on the other with nutrient broth, were inoculated with *Aspergillus niger* or with a mixed culture of bacteria and fungi, the activity of the cultures, after incubation at 28° C. for seven days, was no less than that of the sterile controls. Streptomycin may be reversibly inactivated by cysteine. A less active agent is thioglycollic acid. However, this inactivation is not a property of the sulfhydryl group alone, nor is it limited to organic sulfur compounds, since inorganic reducing agents, as well as ascorbic acid and ketone reagents, also antagonize the antibacterial activity of streptomycin. Whether this antagonism by reducing agents is due to a lowering of oxygen tension, a reduction of the oxidation-reduction potential of the medium, or to some specific chemical reaction, such as the blocking of an active grouping in the streptomycin molecule, or to all of these acting simultaneously, is still unknown. It is entirely possible that the phenomenon is related to the mode of action of streptomycin. This antibiotic displays its greatest activity against bacteria which grow better aerobically than anaerobically; almost all the obligate anaerobes are not susceptible. The antibacterial action of streptomycin may be due to its ability to block some enzyme system, oxidative in nature, which is essential only to the growth of susceptible aerobic bacteria, an enzyme system which anaerobes do not possess. It is conceivable that, in certain parts of the body where reducing agents are present or where a low oxygen tension exists, larger concentrations of streptomycin may be necessary to inhibit the growth of bacteria.

It is evident that the choice of a medium is important in assaying streptomycin and in determining the susceptibility of bacteria to its antibacterial activity. The presence of glucose tends to reduce the activity of streptomycin appreciably in certain media with some, but not all, organisms. This may be due to the reducing properties of glucose, or to the production of some acid by the test organism. In-

* See note at end of the paper.

fusion medium, because of its high content of reducing agents, would also be an unwise choice for assay purposes. A low salt content and a pH of about 8.0 are also preferred. The pH effect may be due to the fact that streptomycin, being an organic base, is not so active in the form of a salt as in a free basic state, or that the active part of the molecule is neutralized by acid.

Several methods are commonly used for assaying streptomycin, namely, the liquid serial dilution method, the agar plate dilution method, the cup-plate or agar diffusion method, turbidimetric, polarographic, and other procedures. For most quantitative measurements, the agar diffusion method is usually used, with *Bacillus subtilis* as the test organism. Paper discs or small cylinders are employed to contain the test solution, which diffuses into the agar, seeded with the assay organism, to produce circular zones of growth inhibition. The activity of the unknown preparation is compared with the inhibition of growth produced by a given standard, and the potency is calculated from the comparative values obtained. Since normal blood contains a diffusible agent which produces large zones with *Bacillus subtilis* as the test organism, a particular strain, SM, of *Staphylococcus aureus* is used in the assay of blood. A turbidimetric method in which a noncapsulated strain of *Klebsiella pneumoniae* is used as the assay organism has also found acceptance for the testing of streptomycin samples. In pharmacological and clinical work, streptomycin can also be quantitatively determined by the slide cell method, similar to that used for assaying penicillin in body fluids; the principal change is the substitution of *Bacterium megatherium* for *Streptococcus pyogenes* as the test organism.

Originally, a unit of streptomycin, or an S unit, was arbitrarily defined as that amount of material which, when present in 1 ml. of nutrient medium, will just inhibit the growth of a given strain of *Escherichia coli*. This unit is a convenient quantitative standard for the study of the production and isolation of streptomycin, as well as for microbiological studies of its antibacterial action *in vitro*. The small size of this unit, however, was rather awkward for pharmacological investigations and clinical use. Consequently, Waksman proposed, in addition to the S unit, an L unit, or that amount of material that will just inhibit growth of a particular strain of *Escherichia coli* in 1 liter of nutrient medium, and a G unit based on the activity of the pure material. For the pure streptomycin base, a G unit equals 1,000 L

units or 1,000,000 S units, and on a weight basis, one microgram is equivalent to one unit. It is of importance that the unit size of streptomycin be clearly understood, especially when attempts are made to compare the efficacy of this substance with that of penicillin, since the two antibiotics are standardized differently. Whereas the Oxford unit of penicillin is based on inhibition of the gram-positive *Staphylococcus aureus* in 50 ml. of medium, the streptomycin unit is defined in terms of its action against the gram-negative *Escherichia coli* in 1 ml. of medium. The Oxford unit represents a much greater *in vitro* activity than does the streptomycin unit. In terms of dry weight, 1 streptomycin unit equals 1 microgram, whereas 1 Oxford unit of penicillin equals 0.6 microgram of penicillin G.

Tissue culture studies, animal experiments, and clinical use have demonstrated that, while its margin of safety is definitely higher than that of all chemotherapeutic agents other than possibly penicillin, streptomycin, at least that which has been used to date, has definite toxic properties. Both the commercial product and the crystalline streptomycin as produced at present will cause untoward reactions in a certain number of patients. The frequency of reactions increases with the size of the dose and with the duration of the treatment. Local reactions such as pain, soreness, and induration at the site of injection are frequent, but become a less serious problem with more purified preparations. Nausea, vomiting, headache, facial flushing, fall in blood pressure, and fainting were seen in some patients and may be ascribed to a histamine-like impurity. Some of the early preparations of streptomycin contained small amounts of such impurities. Pure streptomycin is free from these side-effects. At present, no sample of streptomycin is passed by the producer or the Food and Drug Administration, unless, when injected intravenously into cats on the basis of 300 micrograms per kilogram of body weight, it causes no greater fall in blood pressure than the equivalent of 0.1 microgram of histamine base. Other reactions, such as toxic erythema and cutaneous rash with or without fever and eosinophilia, may occur at times after several days of administering streptomycin. There is nothing specific about the type of skin reaction. It may be caused by abnormal sensitivity of the patient or by some impurities in the streptomycin preparation. The most serious types of toxicity have been observed primarily in manifestations of involvement of the eighth cranial nerve. Tinnitus and vertigo are usually the first symptoms noted. Both auditory

and vestibular functions have been definitely reduced in some patients, particularly in those who received large amounts of streptomycin over prolonged periods. It is not known whether these neurologic disturbances are due to streptomycin or to small amounts of impurities, but all the available evidence suggests that streptomycin itself is at fault. Some renal irritations, manifested by a transient increase in urinary output, hematuria, and the presence of hyaline and granular casts in the urine, have been noted following the administration of large doses of streptomycin. Fatty metamorphosis of the liver and kidney has been observed in animals. However, careful studies on man have failed to reveal any evidence of significant hepatic or renal damage from pure preparations of the drug.

Streptomycin has been administered intramuscularly, intravenously, and subcutaneously, both by intermittent injection every three or four hours, and by continuous drip. It has also been given by the oral route, by nebulization, and by the intrathecal route. For systemic treatment, the intramuscular route is the one of choice. Following parenteral injection, streptomycin is excreted largely by the kidneys into the urine, but the drug was found to be distributed throughout most body fluids, such as ascitic, pleural, peritoneal, bile, aqueous and vitreous humors, and it has been found to enter fetal cord blood and amniotic fluid. When given orally, only occasionally was there any streptomycin in the blood or urine, and then in small amounts. Most of the drug was eliminated in the feces. Apparently, streptomycin passes through the gastrointestinal wall with difficulty, since little appears in the blood when given orally, and only small amounts are found in the gastrointestinal tract when given intravenously (that which is found probably entering from the bile). This persistence and stability in the gastrointestinal tract has been used to advantage in preparing patients for operations on the colon, and for the treatment of typhoid patients and carriers. Oral administration rendered the feces completely negative for *Eberthella typhosa* and considerably reduced the numbers of *Escherichia coli* as well as the general fecal population. Streptomycin administered in peanut oil and beeswax is not absorbed from the muscles as readily as when it is injected as a saline solution; lower serum levels and reduced urinary excretion were obtained with the former method than with the latter. However, absorption of the compound emulsified in "solvecillin" is similar to that following saline solution injections.

Considerable data are being collected on the clinical value of streptomycin. Evidence is accumulating as to the effectiveness of this agent in the treatment of a limited number of infections and its ineffectiveness in the treatment of many others. Streptomycin has been found most effective in tularemia, in meningitis due to *Hemophilus influenzae* infection, in bacteremias and meningitis due to gram-negative bacteria, and in enteric infections. Some heretofore resistant genito-urinary tract infections respond well to treatment with streptomycin, but the results in the routine treatment of urinary infections with streptomycin are disappointing. It is undoubtedly a very useful agent in this type of infection if the causative bacteria are susceptible and if there is a free flow of urine. Encouraging results have been obtained in the treatment of certain types of pulmonary disease, especially if streptomycin is combined with penicillin therapy. Nebulization therapy was effective in providing a reduction of the volume of sputum in patients who had non-surgical, chronic bronchiectasis. Streptomycin proved of value in some cases of peritonitis and warrants a more extensive clinical study. The results in typhoid, brucellosis, cholera, *Salmonella* infections, and wound infections have been inconclusive and disappointing. Although streptomycin has been shown to check and retard the normal course of experimental tuberculosis in guinea pigs, no such clear-cut evidence was obtained for this disease in human patients. It had a palliative effect and was valuable as an adjunct when combined with other established methods of treating this infection. The practical use of this antibiotic in pulmonary tuberculosis must await further study, as soon as adequate supplies become available. However, a case of laryngeal tuberculosis, with only slight pulmonary involvement, and a case of bladder tuberculosis were reported cured by streptomycin.

As has been found with the sulfonamides and penicillin, the sensitivity of a given culture of an organism to streptomycin is characteristic not only of the organism but of the strain as well, different strains varying greatly in this respect. Also, some organisms at times develop a resistance to streptomycin with incredible rapidity. Thus, for example, tubercle bacilli, gonococci, and meningococci have been cultivated whose resistance to streptomycin has been increased a thousand and more times in a short interval. *Salmonella, Shigella, Proteus, Aerobacter,* and *Escherichia* cultures have also been made resistant. This drug resistance is a matter of concern among clinicians and epi-

demiologists. Fortunately, the resistant or adapted variants may not be simultaneously resistant to other drugs and antibiotics. The relation of artificially acquired and naturally acquired resistance to chemotherapeutic agents involves many questions as yet unanswered.

There may be a number of reasons for the failure of streptomycin, or, for that matter, of any other antibiotic therapy. The following five conditions probably account for most failures:

(1) Treatment of infections that are not susceptible to the action of streptomycin: that is, the organism is so resistant that a concentration of streptomycin adequate to inhibit the growth of the organism cannot be maintained in the blood or tissues.

(2) Inadequate dosage may be used, even in the presence of a susceptible organism. It is essential that bacteria be eradicated in the shortest possible time if satisfactory clinical results are to be obtained. This means the administration of large doses from the onset of treatment.

(3) Development of resistance to streptomycin. I have already mentioned this. Resistance appears to take place particularly in bacteremia, and urinary tract infections.

(4) There may be a change in the species of infecting organism during treatment. In urinary and pulmonary infections, which frequently are characteristically polyvalent, the sensitive or susceptible organisms or strains are eliminated or decreased in numbers, and nonsensitive organisms grow and multiply and invade tissues. The change in the bacterial flora of urine and sputum after streptomycin treatment may be very striking.

(5) There may be a localization of infection in an area that cannot be reached by streptomycin. Foreign bodies and tumors should be surgically removed as early as possible. It has been suggested that the reason why streptomycin has proved of so little value in typhoid and brucellosis may be that the causative organisms are found intracellularly, the antibiotic thus being unable to reach them, even though adequate amounts of the drug appear in the blood during therapy.

In conclusion, I would like to add on September 1, 1946, the Civilian Production Administration announced the names of 1,652 hospitals in the United States and the Territories which will act as

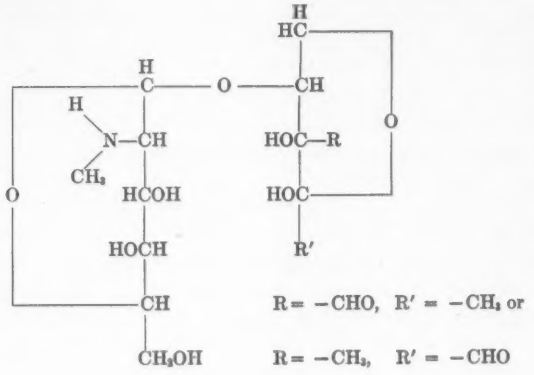
depots in the controlled distribution of streptomycin for civilian treatment. Each depot hospital is allotted a specific quantity of streptomycin available during the month. Any hospital or physician may apply to the nearest depot hospital for needed supplies.* Previous to September 1, grants-in-aid for clinical study of streptomycin, amounting to almost one million dollars, were contributed in equal shares to the National Research Council by eleven pharmaceutical manufacturers constituting the Streptomycin Producers Advisory Committee of the Civilian Production Administration. Dr. Chester S. Keefer, who headed the clinical investigation of penicillin for the Office of Scientific Research and Development during the recent war, was in charge of the clinical trials program.

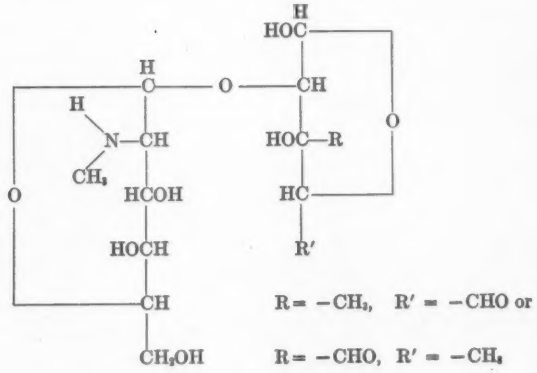
Total U. S. streptomycin production has increased from approximately 3,000 grams in September, 1945, to about 150,000 grams in September, 1946. Of course, not all of this is available for civilian use, because military and other government agencies are also allocated supplies. One to four grams of streptomycin a day for five to fourteen days are usually required in the treatment of infections other than tuberculosis. Large-scale production by several manufacturers soon will not only increase the available supply of streptomycin, but will also lower the cost of this antibiotic, just as was the case with penicillin.

* The C. P. A. has recently suspended its quota system for distributing streptomycin. Hospitals and sanatoriums may now order the drug direct from suppliers, without restriction. However, the amount of the drug which a manufacturer may release is restricted by allocation. No provision is made for distribution through ordinary drug channels, or to physicians individually. Further relaxation of controls has been recommended.

NOTE ADDED IN PROOF, NOV. 25.

One of the following four formulas has recently been proposed by investigators at Merck and Co., Inc., as representing the structure of streptobiosamine:





SECTION OF PSYCHOLOGY

October 21, 1946

Doctors Alice I. Bryan, School of Library Service, Columbia University, New York, N. Y., and Edwin G. Boring, Department of Psychology, Harvard University, Cambridge, Massachusetts:

*Women in American Psychology: Factors Affecting Their Careers.**

To obtain the material reported in this article, we sent a questionnaire to each of the 440 American women who took Ph.D.'s in psychology between 1921 and 1940, and also to each of 440 men, matched individually to the women by university and date of Ph.D. The questionnaire dealt with matters that affect the professional careers of psychologists. We received replies from 245 women, which is about 60 per cent of the corrected population, and from 247 men, which is probably about 30 per cent of the corresponding male population. The replies are dated from December, 1945, to April, 1946.

Results

(1) The women Ph.D.'s appear to have had family backgrounds more favorable to advanced education than the men. The women's parents have had, on the average, more education than the men's. The women have fewer fathers who did not get through high school, more fathers who took advanced degrees after college. The women have fewer foreign-born parents. Jobs of the women's fathers lie higher in the occupational scale than the men's, and more of the women's mothers have had professional positions than those of the men's.

(2) The average picture of how these persons decided to become psychologists would be that they became interested in psychology in their late teens, decided on a career in psychology at about 24, and got their Ph.D. at about 29.

(3) These psychologists, in general, expressed satisfaction with their professional training, and then went on to complain that they had not had more of it. In a list of 25 subjects in which graduate students can be trained, our 492 persons checked 1848 subjects as fields in which they wished they had had more training, and only 408 items as having been emphasized too much in training. This criticism reflects the shift in psychology away from the laboratory and old-

* The lecture was delivered by Doctor Bryan.

fashioned scholarship toward clinical practice and personnel work. Both men and women would have liked more training in clinical techniques, personnel procedures, field work, internships, and statistics, and less emphasis upon foreign languages (especially German), experimental psychology, laboratory practice, systematic psychology, and the history of psychology. Sex differences in these wishes are not striking.

(4) We sought to assess the prevalence of prejudice as affecting employment. Employers have a fear of incompetence in general, sometimes directed against youth, in particular, and sometimes against age. Only little prejudice against political views and activities is reported, and not much more against race and religion. Both men and women are convinced that there is much more prejudice against the female sex (and practically none against the male sex), but this must be considered in relation to the other fact that, in some psychological work, it is helpful to be a woman. Within professional psychology, 'woman's work' and 'man's work' are not always the same (see also item (9) below).

(5) Seven men in ten, six women in ten, have full-time employment in psychology. The men, taken all together, spend 82 per cent of their time in paid psychological employment, the women 65 per cent of theirs. In all kinds of paid employment, the men spend 98 per cent of their time, the women 72 per cent. Responsibilities of the women for household and children are not counted as paid employment.

(6) Women get lower salaries than men, and married women slightly lower salaries than unmarried ones, even when all the persons considered have full-time paid employment in psychology. Salaries tend to increase with age. We think the fact that men in their thirties have recently been doing as well financially as men in their forties to be an artifact of war conditions. Although some of our results are affected by the depreciation of the dollar in the last quarter-century, we believe it to be approximately true that, at the present time, women psychologists, when fully employed, whether married or unmarried, make on the average about 20 to 40 per cent less than men of the same ages, being paid from $1,000 to $2,000 a year less.

(7) Most of the psychologists who were questioned like their profession. Hardly any of them regret what he or she has done within or for the profession. There are slightly more complaints about the present job than about the profession, but not many. The psychologists know how to accept the reality which is theirs.

(8) The women seem almost as satisfied with their profession and their professional activities as the men, although they make it clear that marriage and profession are often in conflict. For many married women in psychology, responsibility to the family becomes more important than professional work. In the great majority of cases, the women accept this potential conflict situation with equanimity, concurrently deriving satisfactions from husband, children, and work.

(9) Both men and women think that women, on the average, are professionally at a disadvantage because of their sex. The men get work more easily. They earn more when they get it. They achieve more, because they lack the women's conflict in marriage and thus get promoted more readily. On the other hand, at least one-fourth of the women claim that their sex has made it easier for them to secure desired work. Presumably, they are the women with the women's jobs in psychology, the jobs in the schools, educational systems, clinics, guidance centers, hospitals, and custodial institutions (cf. item (16) below).

(10) Both married women and married men like their marriages. We tried to give ample opportunity for complaint about marriage, and received complaints, but not in sufficient number to make us believe that there is much error in the direct statements that marriage is fairly satisfying or very satisfying to about 90 per cent of both groups.

(11) On the other hand, the question as to whether marriage helps a professional career brings out a clear sex difference. For men, marriage helps in three-fourths of the cases, while the rate for women is only a little more than one-third. A quarter of the women with full-time employment in psychology say that marriage makes a career more difficult, whereas more than half of the women with part-time employment in psychology either check the same statement or else note that marriage has caused them actually to abandon a career.

(12) Children affect careers much as does marriage. Having children interferes with a woman's career more than a childless marriage, and it is also of less advantage to a man in his profession.

(13) The women and the men show no sex differences in respect of the number of professional societies to which they belong, the number of offices and committee chairmanships which they hold, and the number of meetings which they attend every year.

(14) Men and women with full-time employment in psychology do more professional reading than those with part-time employment.

Married women read, on the average, less professional literature than unmarried women, and unmarried women a little less than men.

(15) The married and unmarried women with full-time employment in psychology spend, on the average, about the same amount of time in research and writing, but very much less time than the men.

(16) We think that items (14) and (15) are to be explained in relation to item (9), which in turn accounts for item (6). There is a sex difference between the interests of women and men, perhaps imposed by the culture. At any rate, it exists, and women view it realistically, accept it, and learn to like it. The women prefer the particular and the personal. The men like the theoretical and the general. All interest inventories bring out this sex difference. Thus, the women like clinical practice, personnel work, and guidance, and do not write about it, because it is personal. The men like research and writing. The men read more than the women, because research and writing are associated with reading, but the women also read more than their research and writing would have indicated. Since research and writing, and the large generalizations that research yields and that are most appropriately written about, all lead to renown, the male psychologists become more famous than the female, and then receive larger salaries, partly for the reason that fame has cash value.

(17) The women in our group spend more time on domestic and familial activities than do the men, but the men spend a good deal of time in this way, mostly on the care of property. About one man in five reports doing some general housework, though none claims responsibility for sewing and mending.

(18) Seven or eight hours a week is all the time that our psychologists average on recreational activities. There is no clear sex difference here. Also, our group contains few "social butterflies," either male or female.

(19) The women average about four weeks' vacation a year, the men about three. The three-month summer vacation, which all academics were once supposed to have, seems to have disappeared from the calendars of the psychologists.

Conclusion

There is nothing new in the statement that a woman is handicapped in a professional career by the common belief that a woman's place is in the home. Our way of life precludes her free concentration on a profession. If she marries, her marriage conflicts with her pro-

fessional work, while if she has children, the conflict is even more severe, unless she gives up much of her professional work. If she is unmarried, she still has, as a rule, to pay more attention to domestic matters than does an unmarried man, and when she marries, her husband seldom takes over the household responsibilities in the way a wife is expected to do, nor does her husband often become her professional assistant corresponding to the manner of many wives.

Women face this inescapable conflict and make the necessary compromises. Some of them hold to their careers and do not marry. Some marry and maintain full-time professional work, remaining, however, at a disadvantage in relation to their male competitors. Other women drop back into part-time professional work, or, abandoning their careers, into little or no professional work at all.

We find that most of our women Ph.D.'s in psychology have accepted this reality and are not protesting, or at least not vigorously, about what they recognize as a necessity of living in our culture. They like marriage. They like their profession. They would, they say, repeat their lives without essential change if they had to live them over. They recognize the disadvantages under which they operate, but they also appreciate the advantages of marriage. Some of them, to repeat, find their sex actually a professional advantage, because there is such a thing as 'women's work' in psychology, and women are wanted for it, prefer it, and do well in it. It seems not to be so well paid as some other kinds of professional activity.

This specific focusing of interest is an important fact about women. In addition to being the acknowledged home-builders, women constitute a group especially concerned with personal and particular matters. For the most part, they like to work with individuals and not to attempt the abstract generalizations. The men, in general, undertake more research and writing and also a little more professional reading. In this way, the women fall behind in the race for fame and also in the race for salary. Most of them seem to accept this reality as it comes to them, to get accustomed to it and like it. They form, on the whole, a very well adjusted group, well-poised, not militant, and yet, when marriage does not interfere, professionally quite as active as the men. We have come to hope that this finding, which surprised both authors, may mean that women psychologists know how to use their own therapy upon themselves, accepting and even learning to like the inevitable, while remaining intelligently aggressive toward reform in many other spheres.

SECTION OF ANTHROPOLOGY

OCTOBER 28, 1946

DOCTOR W. DUNCAN STRONG, Department of Anthropology, Columbia University, New York, N. Y.: *Excavations and Discoveries in Viru Valley of Northern Peru.* (This lecture was illustrated by Kodachrome slides.)

(No abstract received.)

GENERAL CONFERENCE

October 21 and 22, 1946

Conference on "*Teleological Mechanisms.*"

The New York Academy of Sciences held a Conference on "Teleological Mechanisms." Doctor Gregory Bateson, John Simon Guggenheim Fellow, was the Organizing Chairman in charge of the meeting.

The program consisted of the following papers:

Monday, October 21

Morning Session. Chairman, L. K. Frank.

"Self-Correcting and Goal-Seeking Devices and Their Breakdown," by Norbert Wiener, Massachusetts Institute of Technology, Cambridge, Massachusetts.

"The Control of Movements of Animal Organisms," by Arturo Rosenblueth, Institute of Cardiology, Mexico City, Mexico.

Afternoon Session. Chairman, Gerhardt von Bonin.

"Circular Causal Mechanisms in Ecology," by G. E. Hutchinson, Osborn Zoological Laboratory, Yale University, New Haven, Connecticut.

"Circular Causal Systems in Society," by Gregory Bateson, John Simon Guggenheim Fellow.

Tuesday, October 22

Morning Session. Chairman, Harold G. Wolff.

"The Vicious Circle in Causalgia," by W. K. Livingston, M.D., Captain, U.S.N.R.

"Circular Processes in Public Opinion," by Paul Lazarsfeld, Department of Sociology, Columbia University, New York, N. Y.

Afternoon Session. Chairman, H. Brosen.

"The Logic of Signs and Signals in Computing Machines," by John von Neumann, Institute of Higher Learning, Princeton, New Jersey.

"Summary of Theory and Extension to Gestalt Psychology," by Warren S. McCulloch, Neuropsychiatric Institute, University of Illinois, Chicago, Illinois.

SECTION OF BIOLOGY

October 31 to November 2, 1946

Conference on *"Hemorrhage."*

The Section of Biology held a Conference on "Hemorrhage." Doctor Gregory Shwartzman, The Mount Sinai Hospital, New York, N. Y., was the Conference Chairman in charge of the meeting.

The program consisted of the following papers:

Thursday, October 31

"Introductory Remarks," by the Conference Chairman.

Biochemical Aspects. Chairman, Charles H. Best.

"Some Basic Facts of Coagulation," by John H. Ferguson, University of North Carolina, Chapel Hill, N. C.

"Heparin in Blood Coagulation and in Thrombosis," by Charles H. Best, University of Toronto, Toronto, Canada, and Louis Jacques, University of Saskatchewan, Saskatoon, Canada.

"The Relationship of Vitamin K to Hemorrhage and Coagulation," by S. A. Thayer, School of Medicine, St. Louis University, St. Louis, Missouri.

"Hemorrhagic Manifestations Observed in Experimental Deficiency of Pantothenic Acid, Choline, and Cystine," by Paul György, University of Pennsylvania Medical School, Philadelphia, Pennsylvania.

Physiological Aspects. Chairman, Donald D. Van Slyke.

"The Effects of Hemorrhagic Shock on the Circulation," by Dickinson W. Richards, Jr., College of Physicians and Surgeons, Columbia University, and First Medical Division, Bellevue Hospital, New York, N. Y.

Friday, November 1

"Experimental Studies on Traumatic and Hemorrhagic Shock,"

by Magnus I. Gregersen, College of Physicians and Surgeons, Columbia University, New York, N. Y.

"The Capillary Circulation under Normal Conditions and in Acute Hemorrhage," by Robert Chambers and Benjamin W. Zweifach, Washington Square College, New York University, New York, N. Y.

"The Capillary Circulation in Hemorrhagic Shock," by Benjamin W. Zweifach, M. I. Kopac, Richard Lee, and Robert Chambers, Washington Square College, New York University, New York, N. Y.

"The Influence of Humoral Factors of Hepato-Renal Origin on the Vascular Reactions to Hemorrhage," by Ephraim Shorr, Benjamin W. Zweifach, and Robert F. Furchgott, Department of Medicine, The New York Hospital, New York, N. Y.

"Effects of Hemorrhagic and Traumatic Shock on the Kidney," by Donald D. Van Slyke, Hospital of The Rockefeller Institute for Medical Research, New York, N. Y.

"Metabolic Changes Associated with Hemorrhage," by A. E. Wilhelmi and C. N. Hugh Long, Yale University, New Haven, Connecticut.

"The Significance of Blood Volume Alterations in Traumatic Shock," by Everett Idris Evans, Medical College of Virginia, Richmond, Virginia.

Evening Session: Motion Pictures

(1) Functional Activity of the Muscular Vessels in the Capillary Bed (black and white);

(2) Effect of Anesthesia on Peripheral Circulation Following Hemorrhage (colored), shown by Robert Chambers and Benjamin W. Zweifach.

SATURDAY, NOVEMBER 2

Pathological and Clinical Aspects. Chairman, George R. Minot.

"Certain Anatomo-Pathological Aspects of Hemorrhage," by Paul Klemperer, The Mount Sinai Hospital, New York, N. Y.

"Hemorrhagic Manifestations of Bacterial and Virus Infections: Experimental Studies and Pathological Interpretations," by Gregory Shwartzman and I. E. Gerber, The Mount Sinai Hospital, New York, N. Y.

"Abnormal Hemorrhage with Normal Platelets and Normal Clotting Time," by Russell L. Haden, Cleveland Clinic, Cleveland, Ohio.

"Hemophilia," by George R. Minot, Harvard Medical School and Boston City Hospital, Boston, Massachusetts.

"The Manifestations and Management of Purpura Hemorrhagica," by Joseph C. Turner and R. H. Egerton Elliott, Presbyterian Hospital, and College of Physicians and Surgeons, Columbia University, New York, N. Y.

"Clinical Aspects of Hypoprothrombinemia," by Charles S. Davidson and Henry I. Tagnon, Harvard Medical School, Boston, Massachusetts.

NEW MEMBERS

A. Elected from May 15 to September 13, 1946

LIFE MEMBERSHIP

Price, Jerry C., M.D., Cause, Diagnosis and Treatment of Epilepsy. Research Associate in Neurology, College of Physicians and Surgeons, Columbia University, New York, N. Y.

SUSTAINING MEMBERSHIP

Gottlieb, Charles, M.D. Professor of Radiology, New York University, College of Medicine, New York, N. Y.

Pasternack, Richard, Ph.D., Organic Chemistry, Antibiotics. Director of Research, Chas. Pfizer and Company, Inc., Brooklyn, N. Y.

Rabinowitz, Harold M., M.D., Physics and Chemistry as related to Pathologic Physiology. Senior Surgeon, Beth Moses Hospital; Consulting Surgeon, Jewish Sanatorium and Hospital of Chronic Diseases, Brooklyn, N. Y.

ACTIVE MEMBERSHIP

Abell, Richard G., Ph.D., Living Blood Vessels. Assistant Professor of Anatomy, Medical School, University of Pennsylvania, Haverford, Pa.

Albanese, Anthony A., Ph.D., Chemistry and Clinical Application. Assistant Professor, Department of Pediatrics, School of Medicine, New York University, New York, N. Y.

Algire, Glenn H., M.D., Cancer Research, Vascular Physiology. Senior Assistant Surgeon, U. S. Public Health Service, National Cancer Institute, Bethesda, Md.

Anderson, Tirzah W., B.A., M.A., Psychology, Biology. Consultant, Counseling and Faculty Life, Education, National Board, Y. W. C. A., New York, N. Y.

Ashby, Winifred, Ph.D., Immunology, Bacteriology. Senior Scientist, Federal Government, St. Elizabeth's Hospital, Washington, D. C.

Bass, Biren, B.S., Chemistry, Biology. Manager, By-Product Sales, Market Development New Products, Publicker Industries, Inc., Philadelphia, Pa.

Bassett, Samuel H., M.D., Internal Medicine, Human Metabolism. Associate Physician, Strong Memorial and Rochester Municipal Hospitals, Rochester, N. Y.

Batterman, Robert Coleman, M.D., Therapeutics, Medicine. Instructor in Therapeutics, College of Medicine, New York University, New York, N. Y.

Beatty, Clarissa H., Ph.D., Physiology. Instructor, College of Physicians and Surgeons, New York, N. Y.

Been, Robert B., B.S., Physics and Chemistry. Assistant Director, New York School of Optics, New York, N. Y.

Bernardi, Dominic J., Ph.D., Chemistry. Interchemical Corporation, New York, N. Y.

Binkley, Francis, Ph.D., Biochemistry, Clinical Chemistry. Assistant, Hospital of the Rockefeller Institute, New York, N. Y.

Black, Archie, Ph.D., Nutrition, Biochemistry. Head, Nutritional Products Development Laboratory, E. R. Squibb & Sons, New Brunswick, N. J.

Blanchard, Ernest W., Ph.D., Physiology, Biochemistry. Director of Research, Schieffelin and Company, New York, N. Y.

Bottorff, Charles A., D.V.M., Biology. Poultry Pathologist, Lederle Laboratories, Inc., Pearl River, N. Y.

Bourdillon, Jacques, M.D., Physical Chemistry of proteins and viruses. Senior Medical Biochemist, New York State Department of Health, Albany, N. Y.

Boxer, George E., Ph.D., Biological Chemistry. Senior Chemist, Biochemistry, Merck and Company, Rahway, N. J.

Braitberg, Leo D., M.S., Chemistry, Biology. Research Chemist, Pyridium Corporation, Yonkers, N. Y.

Brauer, Ralph W., Ph.D., Biological Chemistry. Instructor in Pharmacology, Harvard Medical School, Boston, Mass.

Brink, Frank, Jr., Ph.D., Physical Chemistry of Cells and Tissues. Associate in Biophysics, Johnson Research Foundation, University of Pennsylvania, Philadelphia, Pa.

Brooks, Chandler McG., Ph.D., Physiology. Associate Professor of Physiology, The Johns Hopkins University, School of Medicine, Baltimore, Md.

Bucca, Matthew A., Ph.D., Bacteriology. V. D. Research Laboratory, U. S. Marine Hospital, Staten Island, N. Y.

Buchbinder, Leon, Ph.D., Bacteriology, Immunology. Senior Bacteriologist, Department of Health, New York, N. Y.

Burch, George E., M.D., Biology. Associate Professor of Medicine, Tulane Medical School, Tulane University, New Orleans, La.

Burkholder, Paul E., Ph.D., Microbiology, Plant Physiology. Professor of Botany, Yale University, New Haven, Conn.

Bush, Frederic A., A.B., Geological Sciences. Chief Geologist, Sinclair Oil Corporation, New York, N. Y.

Butterfield, George P., M.A., Biology, Chemistry. Consultant, Bacteriology and Chemistry, Chicago, Ill.

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